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ABSTRACT

The purpose of this study was to examine the effects of instruction that is organized in two alternative formats--hierarchical (Gagne, 1962) and elaborated (Reigeluth, 1979)--on learner's recall and application of content-specific principles. Sixty-nine college juniors and seniors enrolled in an education media production course studied one of two versions of instructional text dealing with photography-related principles. One version was organized using learning hierarchy prescriptions; the other using elaboration theory prescriptions. No statistically significant differences were found between the two treatment groups. However, the hierarchical version of the materials was considerably shorter and took less time to complete, thus raising questions about the efficiency and cost-effectiveness of instruction designed following elaboration theory prescriptions. Results of the data analyses are displayed in three tables. (6 references) (Author/CGD)

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An Examination of Two Approaches to Organizing Instruction

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Abstract

The purpose of this study was to examine the effects of instruction that is organized in two alternative formats -- hierarchical (Gagne, 1962) and elaborated (Reigeluth, 1979) -- on learners' recall and application of content-specific principles. Sixty-nine college juniors and seniors enrolled in an educational media production course studied one of two versions of instructional text dealing with photography-related principles. One version was organized using learning hierarchy prescriptions; the other using elaboration theory prescriptions. No statistically significant differences were found between the two treatment groups. However, the hierarchical version of the materials was considerably shorter and took less time to complete, thus raising questions about the efficiency and cost-effectiveness of instruction designed following elaboration theory prescriptions.

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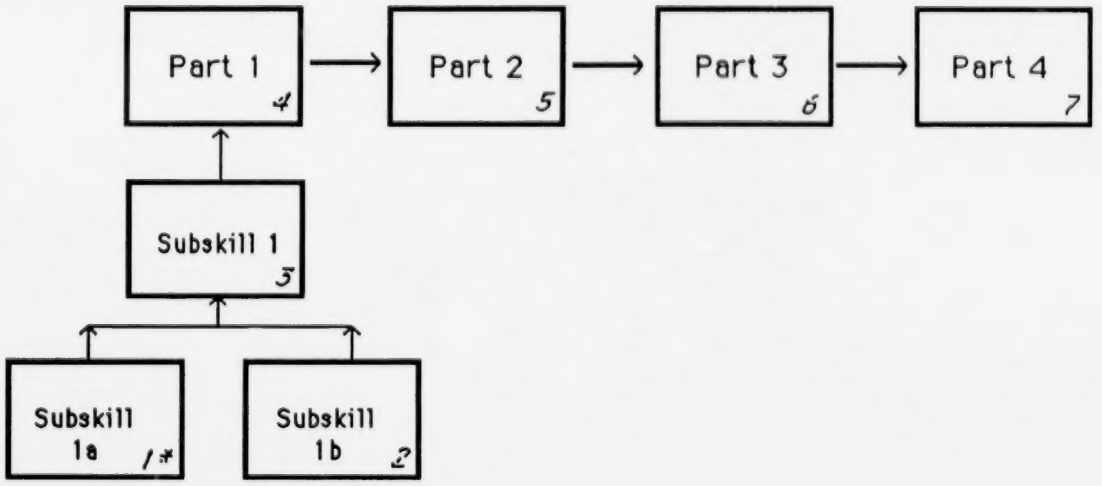
An Examination of Two Approaches to Organizing Instruction

Traditional models of instructional design most frequently have used learning hierarchies (Gagne, 1962) as the basis for organizing and sequencing instruction. Reigeluth (1979) criticized such an approach for creating instruction that is "highly fragmented," "demotivating," and "inconsistent with much knowledge about how learning occurs most effectively." (p. 8). Reigeluth argued that instruction will be more effective if organized using elaboration theory as a guide. The purpose of this study was to examine the effects of instruction that is organized in two alternative formats -- hierarchical and elaborated -- on learners' recall and application of content-specific principles. Secondarily, the study investigated whether these organizational formats are differentially effective for learners with particular cognitive styles.

Overview of Organizational Alternatives

When instruction is designed using learning hierarchy prescriptions, the designer first analyzes the instructional goal by breaking the goal down into its information processing components. Prerequisite skills and knowledge are then identified. When completed, such an analysis presents a hierarchy of skills and knowledge indicating what a learner must know before beginning instruction on the next skill or topic. Thus the organization and sequence of instruction is dictated by the prerequisite relationships of skills and knowledge identified in the hierarchy. As suggested in Figure 1, following this approach, instruction is usually sequenced in a parts-to-whole (bottom-to-top) and first-to-last (left-to-right) manner. Instruction organized according to learning hierarchy prescriptions is purported to be effective (because students learn everything they need to know in order to move on to the next higher skill) and efficient (because extraneous information is eliminated).

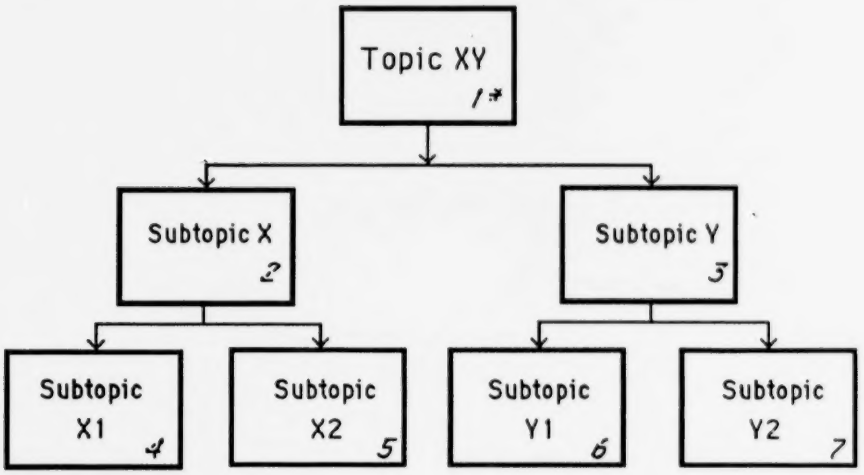
Figure 1. Graphic representation of learning hierarchy sequence.



Italic numbers indicate sequence of instruction.

When instruction is designed following elaboration theory prescriptions, the designer first selects the type of organizing structure -- conceptual, procedural, or theoretical -- that will be the basis for the instruction. Next, this organizing structure is developed; all important concepts, procedures, or principles are identified. The content is then allocated to "levels of elaboration" with the simplest, most fundamental content in an "epitome" (Reigeluth & Stein, 1983). An epitome is a introductory experience which presents the simplest content and provides the learner the opportunity to apply this content. More complex content is allocated to subsequent levels of elaboration. As indicated in Figure 2, the sequence of instruction is suggested by a general-to-specific, simple-to-complex (top-to-bottom) organization. Instruction organized according to elaboration theory prescriptions is purported to be effective and efficient (because new content is presented within the context of already-known content) and appealing (because the learner is aware of the overall context and the relationships among content elements).

Figure 2. Graphic representation of elaborated sequence.



* Italic numbers indicate sequence of instruction.

In addition to the simple-to-complex sequence and single type of organizing content, elaboration theory consists of five other instructional strategy components:

- summarizers
- synthesizers
- analogies
- learner control options (where appropriate)
- learning prerequisites (where needed).

An in-depth discussion of these strategy components can be found in Reigeluth and Stein (1983).

The research on elaboration theory is somewhat limited. This can, in part, be traced to the fact that elaboration theory is purported to be most effective for instruction involving several lessons dealing with several interrelated topics (Reigeluth, 1979) Thus, limited-scope research efforts (e.g., studies of single-concept learning or simple-procedure learning) are not appropriate when studying elaboration theory. The hypothesized advantages of elaboration theory will be realized only if the content is of sufficient amount and complexity that the interrelationships among content elements become important to the learning task.

Given the complexity of elaboration theory and learning hierarchical prescriptions, it is evident that no single study can adequately address all the relevant issues. A research agenda (Smith & Wedman, 1986) was developed to systematically examine the approaches and their effects on learning outcomes. The following questions were taken from that agenda and addressed in this research:
What is the relative effectiveness of hierarchically-based versus elaborated instruction in learning content-related principles? Are these two forms differentially effective across levels of field independence/dependence?
In particular the study sought to compare the effects of materials designed and organized with selected elaboration theory techniques to instruction solely organized using a learning hierarchy. It was hypothesized that instruction organized following selected elaborative techniques, prefaced with an epitome (thus creating a general-to-specific sequence) and rewritten to include end-of-lesson and end-of-set (i.e., end of instructional unit) synthesizers, would produce superior learning to instruction solely following learning hierarchy prescriptions.

The research also attempted to identify any interaction between instructional organization and the cognitive style variable -- field dependence/independence. Field independent learners tend to do well on cognitive tasks that require structuring and reorganizing content; field dependent learners have more difficulty with such tasks (Witkin, Moore, Goodenough & Cox, 1977). Given Reigeluth's charge that content organized following learning hierarchy prescriptions is "highly fragmented," it was hypothesized that the hierarchically organized instruction would be less effective for field dependent learners than the elaborated design because they would have more difficulty integrating the individual skills into integrated knowledge.

Methods

The subjects for this study were junior and senior students enrolled in two sections of an instructional media production course at a large midwestern university. Two sets of materials dealing with photography content were used in the study; both sets were designed to teach the terminal objective. The first set of materials was designed following learning hierarchy instructional prescriptions. The materials were then redesigned following selected elaboration theory prescriptions (an epitome and end-of-lesson and end-of-unit synthesizers) thus creating the second set of materials.

The learning hierarchy version consisted of 72 pages of instructional text organized into four lessons. The elaborated version consisted of 108 pages of instructional text organized into six lessons, the first being the epitome. The epitome required the subjects to make non-numerical predictions using principles related to photographic exposure and image clarity (e.g., If the shutter speed is increased, the aperture size must be made larger to get an equivalent exposure).

Four assessment instruments were used in the study. The Hidden Figures Test (French, Ekstrom, & Price, 1963) was used to measure the subjects along the field dependence/independence dimension. A 12-point pretest that assessed performance on direct application tasks was used to assess prior knowledge of the content. A 14-point posttest and delayed posttest was used to assess mastery of the content on the application level. The delayed posttest was patterned after the posttest but item specifics were changed to minimize item familiarity.

During the first week of the semester, the pretest and the Hidden Figures Test (HFT) were administered. Four weeks after the pretesting session, the subjects were randomly assigned (by coin flip) to study either the hierarchical or elaborated versions of the instructional materials. All studying was done during the regularly scheduled class time; a total of three hours was available for study. The subjects recorded the amount of time they studied the materials. The posttest was given whenever an individual indicated that he/she was ready. One week later, the subjects were given an unannounced delayed posttest.

Results

Pretest results indicated that, with few exceptions, the subjects were complete novices in terms of the photographic content used in the study. Table 1 shows the descriptive statistics for the pretest, posttest, delayed posttest, and Hidden Figures Test results for each treatment group.

Table 1. Mean Test Scores for Treatment Groups by Version

Test	Version	Mean	S.D.	Range	N
Pre	Elaborated	0.58	0.96	0-3	31
	Hierarchical	0.52	0.98	0-4	38
Post	Elaborated	6.32	2.78	1-11	31
	Hierarchical	6.89	3.10	2-13	38
Delayed	Elaborated	5.80	2.87	0-12	31
	Hierarchical	6.89	2.84	1-12	38
HFT	Elaborated	10.87	7.07	2-26	31
	Hierarchical	8.34	3.99	2-17	38

The average study time for the elaborated materials was 114 minutes compared to 88 minutes for the hierarchical materials. This was inconsistent with pilot test results which had indicated approximately equal times for each each version of the materials.

Using the General Linear Model in SAS (1985), a two-way ANOVA was conducted to test the following hypotheses:
1) there would be no statistically significant difference between the two treatment groups' scores on either the posttest or the delayed posttest.
2) there would be no statistically significant difference between field dependent and field independent learners' scores on either the posttest or the delayed posttest.
3) there would be no statistically significant interaction between treatment and field dependence/independence.
Tables 2 and 3 present a summary of these analysis.

Table 2. Analysis of Variance: Posttest

Source	SS	df	F	PR>F
Treatment	5.314	1	0.60	.441
FI/FD	13.608	1	1.54	.219
Interaction	0.098	1	0.01	.916

Table 3. Analysis of Variance: Delayed Posttest

Source	SS	df	F	PR>F
Treatment	19.734	1	2.40	.126
FI/FD	11.696	1	1.42	.237
Interaction	0.098	1	0.16	.694

In the first statistical hypothesis, the posttest and delayed posttest scores of the hierarchical group were compared to the posttest and delayed posttest scores of the elaboration group. For the posttest scores, an F value of 0.60 resulted from the analysis, with a probability ratio of .441. For the delayed posttest scores, an F value of 2.40 resulted from the analysis, with a probability ratio of .126. Thus, no statistically significant difference was found between the two treatment groups' scores on either the posttest and or the delayed posttest.

To test the second hypothesis, posttest and delayed posttest scores of the field dependent group were compared to the posttest and delayed posttest scores of the field independent group. For the posttest scores, an F value of 1.54 with a probability ratio of .219 was obtained. For the delayed posttest scores, an F value of1.42 with a probability ratio of .237 was obtained. Thus, no statistically significant difference was

found between the field dependent and field independent groups' scores on the posttest and delayed posttest.

The third analysis was conducted to check for an interaction between treatment and field dependence/independence for posttest and delayed posttest scores. For the posttest scores, an F value of .01 was calculated with a probability ratio of .91675. For the delayed posttest scores, an F value of .16 was calculated with a probability ratio of .694. Thus, no statistically significant interaction between treatment and field dependence/independence was found. (Note: Similar tests were run using extreme scores (top quartile/bottom quartile) on the Hidden Figures Tests. No significant interactions were found.)

Discussion

The results of this study did not support the prediction that students receiving instruction following elaboration techniques would outperform students receiving instruction following strict learning hierarchy prescriptions. Statistical analysis of test scores indicated no significant difference between the elaborated and hierarchical treatment groups. Such a finding is contrary to Reigeluth's prediction that elaborated instruction will produce more stable cognitive structures, thus improving long term retention. The research findings are discussed below, first in terms of future research and then in terms of implications for instructional design practice.

Elaboration theory was developed as a macro-level approach to organizing instruction, that is, sequencing instruction dealing with several interrelated topics. This instruction was a multi-topic, 1 and 1/2 to 2 hour unit involving application of several complex, interrelated principles. It was expected that the benefits of the integrating potential of elaborated instruction would be detectable in such a situation, especially with learners of such low levels of prior knowledge. It is possible that the content used in the study was still not of sufficient amount and/or complexity for the purported advantages to be realized. Further investigation with larger amounts of complex content may provide support for elaboration theory prescriptions and help answer the question of when to use the prescriptions.

The subjects' perceptions of the learning task and materials may have influenced their performance on the posttests. Subjects working with the elaborated materials first studied the epitome, which presented the content in a general manner without mention of numerical relationships, and then studied a more detailed treatment of the content. Subjects working with the hierarchical materials were presented with only the detailed content. It is possible that the elaborated treatment group retained the general relationships and tended to dismiss the numerical specifics. Future research might assess learners' ability to apply the principles in both general and numerical applications to determine if the two sets of materials are differentially effect at these two levels.

Students' performance was surprisingly low for both groups with means of 6.32 and 6.89 (on a 14 point scale) for the elaborated and hierarchical, respectively, on the immediate posttest and 5.80 and 6.89 (on a 14 point scale), respectively, on the delayed posttest. The materials were developed to have a high conceptual density in order to heighten the need for integration of information. However, the conceptual load may have been so high that students became overwhelmed and undermotivated. Further research with these same materials may utilize several sessions in order to avoid this potential problem.

The failure to identify an interaction between the treatment variable and field dependence/independence does not rule out the possibility that learner variables might have confounded the research findings. Cell sizes were rather small to detect such interactions. Future research involving larger samples or other measures and dimensions of cognitive style might reveal stable relationships which could be incorporated into elaboration theory or learning hierarchy prescriptions.

In spite of the failure to find a significant difference that could be attributed to instructional treatment, this study has implications for instructional design practice, at least when dealing with a few interrelated principles. The presence of the epitome lesson and the end-of-lesson and end-of-set synthesizers made the elaborated materials approximately 50% longer than the hierarchical materials (108 pages versus 72 pages). Thus, if materials' cost is an issue, designers might opt for a hierarchical organization because of reduced production/duplication costs. The extra length of the materials was directly related to the amount of time the subjects took to complete the material, an average of 114 minutes for the elaborated version versus 88 minutes for the hierarchical. (And, interestingly, the increased time on task did not bolster the performance of the students interacting with the elaborated version.) Thus, if learning efficiency is an issue, designers might again opt for a hierarchical organization.

Conclusion

The results of this study offers no support for the use of elaboration theory prescriptions when designing instruction dealing with a few interrelated principles. Three conclusions stand out. The general-to-detailed sequence and periodic synthesizers resulted in materials that were: 1) more expensive, 2) less efficient, and 3) no more effective than materials designed following learning hierarchical prescriptions. Perhaps future research dealing with larger amounts of content will provide evidence to the contrary.

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